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COMBINED PRODUCTION OF STARCH AND ALCOHOL IN ALCOHOL PLANTS

[Kombinirovaniye proizvodstva krakhmala i spirta na spirtovykh zavodakh]

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COMBINED PRODUCTION OF STARCH AND ALCOHOL IN ALCOHOL PLANTS

by

M. Ye. Burman and Ye. I. Yurchenko

The starch-syrup industry is an important part of the national economy: syrup and glucose are valuable sugar products used in the confectionary and bakery industries and in the production of medicine; starch and dextrin serve as auxiliary materials in the textile, light and meat industries and in a number of machine-building and chemical industries.

The large rise in production of food products and textiles projected for the 1959-1965 period, as well as the manufacture of new kinds of products, will require a 1965 output of not less than 450 thousand T of syrup, 300 thousand T of starch and about 100 thousand T of glucose.

The problem could be solved several ways, the most important of which is remodelling existing maize-processing plants and building in southern regions of the USSR a number of new giant combines with a capacity of processing 100-450 T of maize per day. However, in central regions of the RSFSR and a number of Union republics where plantings of potatoes are regularly being increased, the basic kind of raw material will be potatoes. Increasing the production of potatoes near starch-syrup plants will make it possible to utilize more completely the capacity of many existing plants of small and medium size and lengthen the operating season of potato grating and dry starch plants to 200-220 days per year. The specific properties of potato starch are responsible for its primary value as a food product (in the form of dry jellies, pudding flour, etc.), in connection with which potato raw material should primarily be turned to the production of starch and grain used for syrup and glucose. The production of potato starch will require building a number of new plants, primarily of small capacity, in eastern regions of the RSFSR.

However, all these measures will not ensure a sharp rise in the output of starch. In some regions (Yaroslavskaya, Ivanovskaya), where there is high production capacity, the supplies of potato raw material will not provide complete plant loads. In other regions with good prospects for raw material, existing plants are small and not suitable for prolonged operation under winter conditions. The creation of new plants for converting potatoes and grain to starch products must be based on comprehensive evaluation of the economy of different types of plants, the possibility of maximum inclusion of local raw material and processing raw material with least losses.

One possibility for additional production of starch and creation of new plants with the expenditure of minimum capital investments might be the organization of starch departments in alcohol plants and the combined conversion of potatoes into starch and alcohol.

The essence of this method is that all potatoes reaching the alcohol plants are first converted into starch; wastes in the form of mezga and trap starch, which contain a small amount of starch, are sent to the alcohol department for the production of alcohol.

In itself the idea of combined processing is not new and in past years has been brought up repeatedly. However, in previous statement of this question, specifying building alcohol departments in starch plants with the use of waste mezga (with a starch extraction coefficient of 80-82%), it could not have been successful as the amount of starch in the raw material passed on to the alcohol department was clearly inadequate for the profitable production of alcohol. In addition, it was hardly feasible to build new alcohol departments and boilers for them at starch plants.

At present the question is being stated differently. Although the demand for alcohol for technical and food purposes and especially for a number of chemical industries will increase significantly in 1959-1965, the production of alcohol will be primarily increased by developing production of synthetic ethyl and sulfite alcohol. Therefore, the small decrease in the production of alcohol from food raw material can have no significant reflection in the alcohol supplies for the national economy.

It is intended to produce starch by organizing a simplified scheme in alcohol plants specifying the extraction of not more than 60% of the starch contained in the potatoes and transfer to alcohol production the starch-rich mezga (65-70% starch in dry substance) as well as part of the cell juice of the potatoes. Reduction of the amount of starch sent to the alcohol plant could be completely or partially compensated by the addition of grain, depending on operating conditions. In this way the daily production of alcohol would hardly be reduced at all.

Thus, the profile of the plant, which after remodelling will become an alcohol-starch plant, is changed significantly. In such combined processing of raw material it becomes possible to utilize the starch contained in the potatoes almost completely, while at present only 80-83% of the starch is extracted in large starch plants and in the vast majority of small plants not more than 75%. Increasing the output of starch in modern starch plants entails complicating the scheme, installing new power equipment (separators, centrifuge, blade sieves, etc.). In this case a very simplified scheme can be used with a smaller number of graters and sieves; utilization of a settling-washing centrifuge also makes it possible to eliminate the trough station. In this variant the arrangement of technological equipment requires less space. All

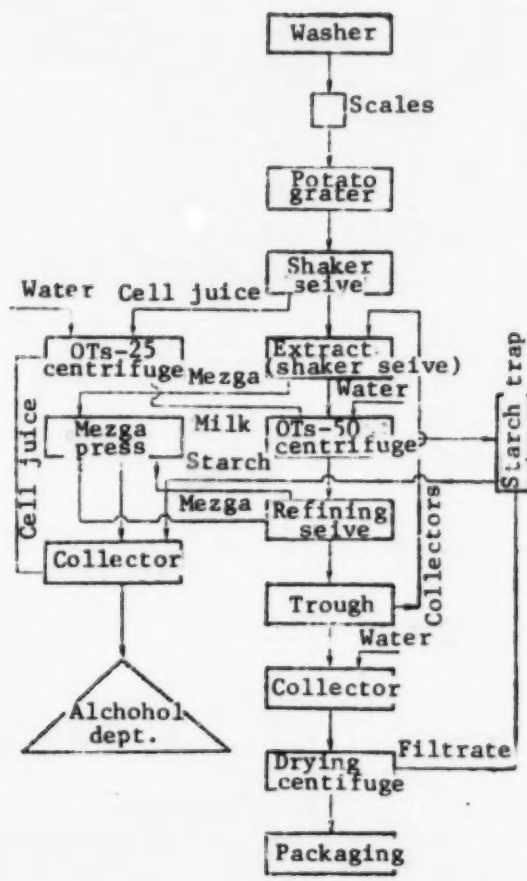
this makes it possible to do without the construction of additional rooms in a number of alcohol plants and place starch equipment in existing areas.

Capital expenditures for equipping the alcohol plant and installing an additional power supply unit will be much less than for the construction of a new plant. It must be taken into account that warehouse facilities, the hydro-transporter, washer, etc., at the plant can be utilized. With proper preparation the starch department can be organized in 3-4 months, i.e. in one maintenance period.

The question can be raised as to what degree the necessity of reducing the expenditure of grain for alcohol production is tied up with the idea of compensating the extraction of 60% of the starch from potatoes by the corresponding addition of grain. An exhaustive answer can be given to this. In the starch-syrup industry a significant amount of grain is converted to syrup and starch; however, not always effectively. For example, in the conversion of wheat to starch according to the scheme used at present the starch yield is only 40-45% and 20-25% of the dry wheat substance is irretrievably lost. With the combined processing of raw material in a starch-alcohol plant not only can the starch found in the grain be better utilized, but the loss of dry substance can be avoided and a valuable recovery made — grains — for the needs of live-stock raising. Such combination is an important method of reducing the cost price of both alcohol and starch. It offers a path toward eliminating the harmful effect of juice water in starch production as a large part of this water will be used in the production of alcohol as a rich nutritive medium for yeast. Instead of potato mezga of low value the live-stock raisers will receive a more valuable feed in the form of grains. Organization of starch departments will not require a large additional work force or construction of new housing.

With such organization of production a significant reduction should be expected in operational expenses.

In March, 1958, the authors of this article visited the Berezina Alcohol Plant where 60 T of potatoes are processed every day. The plant operates about 200 days per year. This is a typical medium-sized plant, producing about 700 decaliters of alcohol per day. On-site study of the question showed that with the installation of a small amount of starch equipment in the existing building, the production of joint starch could be organized with its subsequent shipment to the Minsk Syrup Plant for the manufacture of syrup. The daily production output converted to commodity starch is over 7.5 T. Engineer Yurchenko has suggested the flow diagram for starch production shown in the illustration.



Process flow diagram for the combined conversion of potatoes to starch and alcohol.

The organization of a starch department at the Berezina Alcohol Plant will require additional installation of the following technological equipment:

Potato screw conveyer.
 Potato elevator.
 Potato washer with stone trap (instead of the existing one).
 ST-60 potato grater.
 Two-level extractor.
 OTs-25 settling centrifuge.
 OTs-50 settling centrifuge.
 Three 1000 mm shaker sieves.
 350 x 810 drying centrifuge.
 Mezga press.
 Five displacement pumps with ball valves.

With separate processing of 60 T of potatoes to produce alcohol and grains, the balance of products is in the following form.

With a 17% starch content, 60 T of potatoes contain 10.2 T of starch.

The expenditure of grain for malt we take as 14% of the weight of dry starch substance, i.e. 1.4 T.

We take three kinds of crops for malt:

60% barley with a starch content of 50%.
 20% oats with a starch content of 36%.
 20% millet with a starch content of 48%.

The total starch introduced with malt (taking into consideration a 16% loss in malting) is 0.55 T.

The yield of alcohol from potato starch (at the 1957 production level) - $10.2 \cdot 65.2 = 665$ decaliters.

Alcohol from malt starch - $0.55 \cdot 61.6 = 33.8$ decaliters.

Total alcohol - $665 + 33.8 = 698.8$ decaliters.

Grains produced - $698.8 \cdot 11 = 7687$ decaliters or 77 T.

With the separate production of starch from wheat with daily processing of 12 T of grain:

Total dry substance of grain $\frac{12 \cdot 85}{100} = 10.2$ T.

Starch yield, 40% of total dry substance - 4.1 abs. dry starch.

Yield of commodity starch - $4.1 \cdot 1.25 = 5.1$ T.

Irretrievable losses of dry substance (20% of the weight of the grain) are 2.4 T.

Low-value feed is produced with a total content of dry substance - $10.2 - (4.1 + 2.4) = 3.7$ T.

With the joint production of alcohol and starch the balance of products takes the following form.

60T of potatoes with a starch content of 17% contain 10.2 T of starch; of this amount 60% of absolutely dry starch, or 6.12 T, is extracted in the form of commodity starch, the yield of which is $6.12 \cdot 1.25 = 7.65$ T.

The remainder of the abs. dry starch, 4.08 T, is transferred to the production of alcohol. The above indicated 6.12 T of starch is compensated by grain with a 50% starch content, requiring 12.24 T of grain.

The amount of grain for malt necessary for this processing is normally 16% of the starch weight or 0.98 T.

The amount of grain for malt for processing potato mezga returned from the starch plant, normal 14% of the starch weight, is 0.56 T.

The total expenditure of grain for malt is 1.54 T.

Let us take crops of barley, oats and millet in these proportions.

The amount of starch introduced by malt grain, taking into account losses in malting, is 0.61 T.

Total starch for conversion to alcohol - $4.08 + 6.12 + 0.61 = 10.81$ T.

The yield of alcohol from this amount of starch - $4.08 \cdot 65.2 + 6.73 \cdot 63.2 = 691$ decaliters.

The average yield from a ton of conventional starch is 63.92 decaliters.

The total produced in combined conversion

Alcohol		691 decaliters
Commodity starch		7.65 T
Grains	. .	7600 decaliters or 76 T

Calculation of the cost price of dry starch and alcohol in combined processing at the Berezina Alcohol Plant.

60 T of potatoes with a 17% starch content at a cost of 478 rubles 60 kopecks per ton = 28,716 rubles.

The cost of raw material less the value of waste
 $28,716 - 6128 = 22,588$ rubles.

The cost of raw material per 1 T of dry commodity starch
 $22,588 : 7.65 = 2953$ rubles.

Justification of value of waste. 40% of the starch, or 4.08 T, remains in the mezga; 50% of this amount is transferred to alcohol production with the value of the mezga (11 rubles), 80% of the weight of the potatoes, totalling 528 rubles.

The remaining 50% of the starch, i.e. 2000 kg, is transferred (at the cost of raw material starch) at a total value of 5600 rubles.

$478 : 170 = 2$ rubles 80 kopecks per kg,

Total value of waste is $528 + 5600 = 6128$ rubles.

The cost of conversion we take at 75% of the actual existing level

$$\frac{673 \cdot 75}{100} = 505 \text{ rubles.}$$

Plant cost price of 1 T of starch is $2953 + 505 = 3458$ rubles.

The planned cost price for 1958 has been determined at 3576 rubles. Therefore, cost price per ton of commodity starch is 118 rubles.

In the production of 1500 T of commodity starch the savings will be

$$1500 \cdot 118 = 177,000 \text{ rubles.}$$

The cost of raw material for the production of 691 decaliters of alcohol is determined from the following calculation.

Potato mezga with a 40% starch content $2.80 \cdot 2000 = 5600$ rubles; value of mezga at selling price - 528 rubles.

Total value of mezga - 6128 rubles.

Grain (wheat)	12.1412 =	17,283 rubles.
Malt (barley)	0.9.1219 =	1097 rubles.
Oats	0.3. 950 =	285 rubles.
Millet	0.3.1330 =	399 rubles

Total cost of raw material 25,192 rubles.

Grains waste - 75 T @ 5 rubles = 375 rubles.

Cost of raw material less waste - 24,617 rubles.

Cost of raw material per decaliter - 24,617 : 691 = 35 rubles 60 kopecks.

Cost of processing - 9 rubles 48 kopecks.

Total plant cost price of 1 decaliter of alcohol in joint production is 45 rubles 08 kopecks (actual cost price at the Berezina Alcohol Plant in 1957 - 51 rubles 22 kopecks).

With annual production of 100 thousand decaliters of alcohol the savings is 614 thousand rubles.

Total annual savings for alcohol and starch

$$614 + 177 = 791 \text{ thousand rubles.}$$

The Belorussian SSR Economic Council, in working out future plans for the development of the food industry for 1959-1965, has projected combined production of starch and alcohol from potatoes at 12 alcohol plants with the manufacture of joint and dry starch, glucose and dextrin. Total starch products, converted to dry starch, to be manufactured in these plants by 1965 is suggested to be 9.3 thousand T.

Conversion of potatoes to starch and alcohol, using the starch process flow diagram of Ye. I. Yurchenko, is already planned for the Berezina and Lyntup Alcohol Plants in 1958.

Total annual savings for the 12 plants will be approximately 9.5 million rubles.

Tentative calculation has shown that in comparison with capital investments for new starch plants, this variant will give a 48 million ruble savings.